16633 SE 17th Street
Bellevue, WA 98008

July 12, 2002

Mr. David L. Dye, PE
Urban Corridor Administrator
Washington State Department of Transportation
401 Second Avenue South Suite 300
Seattle, WA 98104-2887

Ms. Grace Crunican
Director, Seattle Transportation
Room 400
600 – 4th Avenue
Seattle, WA 98104-1879

Dear Sir and Madam:

It is my pleasure to transmit to you the Alaskan Way Viaduct, Phase 1 – Retrofit Option report. This report has been prepared by the Seattle Section of the American Society of Civil Engineers (ASCE) Expert Team in cooperation with the City and WSDOT project team. The report evaluates from a technical standpoint the feasibility of several options to retrofit the Alaskan Way Viaduct structure. Mr. Victor Gray and Neil Twelker proposed one of these options and the project team of the City and WSDOT developed the other options.

Our report concludes that the proposal from Gray and Twelker is not technically sound and the options by the project team are not economically justified. It is not to say that the project team should not continue to evaluate retrofit options, but the options suggested at this time should not be considered further.

The Seattle Section of ASCE appreciates the opportunity to provide this service for the City and WSDOT and stands ready to assist the project sponsors in the evaluation of the project as options are developed and refined.

Sincerely,

Theodore T. Bell, PE
Chair, ASCE Seattle Section Expert Team

Encl. – Phase 1 Report

Cc: Maureen Sullivan

ASCE Seattle Section Board

Bob Chandler

ASCE Expert Team

Alaskan Way Viaduct

Phase 1 - Retrofit Option

April 24, 2002

Committee Members

Adrian Arnold
David Baska
Theodore Bell
Jack Locke
Dan Mageau
Douglas Myhre
Loren Sand
Joe Scott
Anne Symonds
Jack Tuttle
Ray Upsahl

Alaskan Way Viaduct

Phase 1 - Retrofit Option

Introduction

The Alaska Way Viaduct was damaged by the February 28, 2001 Nisqually earthquake. Emergency repairs were made to the Viaduct by the WSDOT and it is open to traffic with a legal load limit in one lane and a five-ton limit in the other two lanes. The highway carries approximately 110,000 vehicles per day and is a vital part of the Seattle's transportation system.

The majority of the viaduct is a two level concrete frame structure that was designed and constructed in the early 1950's. It is reinforced concrete with pile supported foundations. Typical construction is three-span units that separated from adjacent units by 2-inch expansion joints.

This report will focus on the viaduct retrofit and related views/comments option from Victor Gray & Neil Twelker. The ASCE Panel was provided with previous reports and information and was afforded the opportunity to meet with WSDOT staff, WSDOT consultants and Gray & Twelker. All meetings were informative and in a question and answer format. While the ASCE Panel had limited time and resources, our committee felt that a good overview and objective evaluation can be made. One objective was to see if there were unexplored ideas or issues that should be addressed by the project team. We also took a hard look at the thoughts and ideas expressed by Gray & Twelker.

Our team's major concern is that structural sufficiency alone does not address all issues needed to support a decision regarding the Viaduct. The major issues include:

- Structural integrity of the Viaduct (structure).
- Traffic capacity of the Viaduct (traffic).
- Risk of damage or loss of the Viaduct (risk).
- Time to put a "safe" Viaduct in operation (time).
- Financial availability of funds to either retrofit or replace the viaduct (cost).
- Political will on the part of the leadership responsible for planning and financing future actions for repair or replacement of the viaduct and addressing where this project fits into the overall regional transportation scheme (political).

These issues cannot be decided in isolation of the others. However, the merit of the retrofit proposal by Gray & Twelker can be evaluated with its viability being considered. The following thoughts are provided as the basis for the recommendation of our team.

Present State of the Viaduct Structure

The present structure has received emergency repairs for the damage from the Nisqually Earthquake and is open to traffic. Several reports have been prepared and studies are now underway to determine what is the best approach to retrofitting or replacing the structure. The condition of the viaduct structure involves a number of separate elements and their condition is summarized based on the reports and presentations made to the Expert Team.

Structural

The structure is approximately 50 years old and has the normal wear and deterioration of a bridge that has had heavy traffic use and exposure to the elements. The deck surface has considerable wear with reinforcing steel exposed in places. A high level of salt intrusion in the concrete with the related corrosion of the steel and concrete spalling has occurred. Reinforcing steel details in the structure are typical for the era with deformed square bars, very light tranverse steel, and very short lap lengths. Welding compensated the short lap lengths. However, based on a sample of steel taken from a damaged section the steel was not a good grade for welding and the welding process unreliable. The columns supporting the structure do not have sufficient transverse reinforcement to withstand the lateral force of a substantial earthquake.

Foundations

The majority of the viaduct is supported by piling that have been driven through or into the hydraulically deposited fill created in the early 1900's. This deposited material provides minimum support and is subject to liquefaction in an earthquake with an intensity considerably less than a design level event. The existing piling is largely unreinforced concrete and is vulnerable to bending and shear under lateral forces of liquified soil movement.. The piling has limited penetration in to solid ground or does not penetrate through the unconsolidated fill. The lack of penetration into solid ground is in the southern portion of the structure.

The viaduct columns are supported on thin pile caps that have no top reinforcing, so bending resistance is not adequate. Further, there is not sufficient shear reinforcement in the pier caps. The piles do not have positive tension reinforcement connections to the pile caps to resist uplift or overturning.

Traffic

The viaduct carries approximately 110,000 vehicles per day and serves as a prime arterial for traffic destined to the downtown, through north-south flow and critical freight and commercial traffic. The roadway has three lanes in each direction with connections to the surface street system. These connections are not designed to handle the speeds of the mainline and are deficient in merging lengths and sight distances.

The viaduct connects to the Battery Street Tunnel that has two lanes in each direction, which causes a bottleneck.

Earthquake Damage

Major damage of the structure from the Nisqually Earthquake occurred at the deck units 97 to 100 in the vicinity of Washington Street. The upper knee joint on the east of frame 100 was seriously cracked and spalled, and the exposed reinforcing at the joint was fractured and unbonded. The bridge unit has drifted between 3 inches at frame 100 and 1.5 inches at frame 97. This movement likely has occurred over a period of time and is not entirely the result of the earthquake. There is cracking in the bottom of the tranverse girders, which is consisitent with the lateral movement of the structure noted in this area. The girders are not reinforced for flexure with the load reversals caused by lateral loading. WSDOT has repaired the structure and it is open to traffic

After the Nisqually Earthquake there was some liquefaction of the soils in the area of the viaduct. The 1949 and 1965 earthquakes also had localized areas of soil liquefaction. The City of Seattle has repaired settlements under the sidewalk along the seawall. A large area was repaired in the vicinity of the Seattle Waterfront Park.

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Utilities
The viaduct is support for a major power gird servi ng the downtown area and is essential to the distribution of electrical power to the area. Other utilities including water and sewer are located in the area either under or adjacent to the viaduct. There is a the Waterfront Trolley operating under the viaduct for a portion of the route along the waterfront.

Seawall
The City's Alaskan Way seawall extends from Washington Street on the south to Bay Street on the north, a distance of approximately 7,900 feet. There are several types of walls constructed in 1916 and 1934. The 1916 construction was a pile-supported concrete wall, some of which has since been replaced. The remainder of the seawall was built in 1934 with a height varies from 21 to 40 feet. The 1934 wall is attached to a pile-supported platform or wharf that varies in width from approximately 40 feet to 60 feet. The pile-supported platform provides horizontal and vertical load relief for the wall by supporting the roadway and fill area. This wall is constructed of a concrete, steel sheeting and untreated timber platform.

The following summarizes the existing condition of the seawall based on the report, *Preliminary Analysis of Existing Alaskan Way Seawall, Executive Summary* prepared BERGER/ABAM Engineers, Inc. for the City of Seattle and the WSDOT.

- The wall has experienced considerable damage by marine borers in the relieving platforms that have been inspected by the City. The steeling sheeting was to serve as a curtain to block seawater and marine borer intrusion. However, the damage near Waterfront Park shows that corrosion has eliminated this protection.

- The structures that make up the seawall were not designed to handle seismic loadings. It is unlikely that they would have reserve capacity to meet any seismic standard. It is highly unlikely that the wall could resist pressures that would be created by a liquefied soil mass.

Retrofit Feasibility

Background information evaluated by the Expert Team includes reports and presentations. The presentations were by the project team and Gray and Twelker. Considerable information is available on the existing condition and sufficiency of the Alaskan Way Viaduct. The principal documents that were review by the team were:

1. *Seismic Vulnerbility of the Alaskan Way Viaduct: Final Summary Report. Dated July 10, 1995. University of Washington, S. L. Kramer and M.O. Eberhard.* This report reviewed the structural design and construction, performance in past earthquakes, and compared it to similar earthquake events on the Oakland Cypress and San Francisco Viaducts that collapsed or were damaged. The report continued to evaluate the viaduct's seismic vulnerability. This included ground response, liquefaction hazards, and structural performance. The conclusion was that the Alaskan Way Viaduct was clearly vulnerable to severe damage and possible collapse in a design-level earthquake.

2. *Alaskan Way Viaduct - Independent Review of Frame 100, Summary Report, Dated April, 14, 2001. T. Y. Lin International.* The WSDOT had David Goodyear perform a walk-through inspection of frames 97 to 100 after the Nisqually Earthquake. The follow-on report detailed the deficiencies and made recommendations for actions to be taken to protect the structure and public.

This included emergency retrofit, monitoring of key structural elements, strengthening of the lateral system, and evaluation of the drift conditions.

3. *Alaskan Way Viaduct - Report of the Structural Sufficiency Review Committee, Dated June 28, 2001. T. Y. Lin International.* The committee reviewed existing data, prior recommendations, and evaluated minimum acceptance standards for structural performance and the relative cost efficiency in achieving these standards. This information served as a basis for developing options for the viaduct. The options for study were; 1) to repair frames 97 to 100, 2)replace the structure as soon as financing, planning and engineering can be completed, and 3)full retrofit to current standards. The recommendation was to replace the structure. This was based on the consideration "that even though a comprehensive seismic retrofit might achieve a level of safety comparable to a new structure, the eventual deterioration of the current structure due to aging would exact a greater sum of financial resources for maintenance and be less reliable than a new structure built to current seismic design standards."

4. *Correspondence Relating to the Gray and Twelker Proposal.* The Gray and Twelker Proposal was submitted to the Mayor Paul Schell of Seattle and WSDOT Secretary Doug Mac Donald. Their proposal was to select a three-span unit to design a base isolation system and then select a system to protect against liquefaction. This would be constructed and installed in a short time frame to determine the cost, which would then provide a basis for determining the cost of retrofitting the entire viaduct. The three-span unit could be tested to determine how it reacted to ground vibrations.

5. *Preliminry Analysis of the Existing Alaskan Way Seawall, Executive Summary, Dated March 2002. BERGER/ABAM Engineers, Inc.* This report provided an assessment of the of the existing seawall and an analysis of the probable structural performance of several sections of the wall in a seismic event that has a 10 percent chance of being exceeded sometime in the next fifty years.

Review Team Assessments

The expert team has evaluated the data provided and has prepared their assessment of retrofitting the existing structure. This assessment is presented in the principal areas of concern.

Foundation Sufficiency Considerations and Improvement Options

There is a valid concern as to the adequacy of the pile foundations for the southern part of the elevated structure where the depth of potentially liquefiable soils extends below the pile tips. This probably needs further study because of the lack of lateral stability. This is required in either a retrofit or replacement option.

The foundation issues for the Viaduct need to be assessed with and without stabilizing the seawall. It is our understanding that stabilizing the seawall may require less foundation work, and less cost, compared to strengthening the Viaduct. Therefore, risk and cost to the Viaduct alternatives with and without the seawall stabilization should be assessed

The design team needs to consider the effects of the new foundation installation and/or ground improvement on the adjacent buildings as well as on the many utilities in the area. Those buildings in the area that are founded on shallow footings will be susceptible to settlement from construction vibrations. It will be hard to control these vibrations and soil loss (say from a blow out in a drilled shaft) during construction

Structural Deficiencies and Upgrade Options

A proposal has been put forward by Gray and Twelker to use base isolation to reduce the loads imposed on the superstructure. The level of detailed analyses to model the response to the structure given the level of movement that would be induced during an event of comparable size to the Feb 2001 event has not been done. However, the WSDOT estimates that the magnitude of movement between the three-span elements of the structure would be more than what can be practically incorporated into the existing structure. This is primarily because of the limited expansion that can occur between the three-span frames. Additionally, the change in the fixed joint at the pile caps to a hinged joint puts excessive loads at critical elements of the structure.

The replacement versus retrofit issue is complicated by evidence that the structure is exhibiting considerable wear and tear regardless of it's ability to resist lateral forces. A well designed concrete bridge should have a useful life longer than 75 years, however, there are certain key features that were done in this design that result in a shorter life. They include inadequate concrete cover over the slab reinforcing steel (steel exposed at some locations), welding, and poor reinforcing steel splice detailing. The T.Y. Lin report suggests that the spalling of concrete around critical reinforcing steel is just beginning and is likely to accelerate. Loss of bond between steel and concrete may mean loss of load carrying capability.

Any retrofit plan should include considering the use of a thin overlay (micro-silca) of the bridge decks and strengthening of the cross-beams that are weak in shear.

Seismic Issues and Remediation Options

Based on the discussions, it appears that trying to fix one aspect of the structure's response to a seismic event may well cause another part of the structure to become the weakest link . The fix may not reduce the risk of severe damage or collapse of at least parts of the structure. Further, if the design team's assessment of the capability of the existing reinforcement to handle the projected seismic loads is correct, there is probably nothing that can be done to improve the earthquake resistance of the existing Alaskan Way Viaduct to the level needed. Nearly full replacement in kind of the entire structure would be required.

It is fair to question the reliance on the results of tests on only one piece of reinforcing steel as being representative of the condition of all reinforcing in the structure. This may be right, but a broader sampling and testing of the existing steel would provide a better database for their conclusion.

Selection of Seismic Design Criteria

The studies of viaduct and seawall stability have been completed using the seismic design criteria of current and proposed codes. The design criteria in the codes have become increasingly more stringent as we learn from past earthquakes and from on-going research. The soon-to-be adopted AASHTO code will require two levels of seismic performance: a level where the bridge remains operational during ground shaking with a 50 percent chance of exceeding in 75 years (33 percent in 50 years), and a level where the bridge does not catastrophically collapse during ground shaking with a 3 percent chance of exceeding in 75 years (2 percent in 50 years). As a basis of comparison, the current code has a single performance criterion of collapse prevention during ground shaking with a 10 percent chance of exceeding in 50 years.

Design Ground Motions

Predicting the seismic performance of the viaduct, seawall, and foundation soils for both requires estimating future ground motions. We have reviewed the procedures used to develop the design ground motions and found them consistent with the standard of practice. However, some of the simplifying assumptions used in the analyses (e.g., one-dimensional wave propagation and linear soil behavior) may not be appropriate for this site and add further uncertainty to the accuracy of the ground motion estimates. The review team does not necessarily recommend more detailed analyses, but cautions WSDOT and the City of Seattle in placing too much faith in the accuracy of the ground motion predictions.

Liquefaction

The potential for liquefaction of the existing fill and tide flat materials is a concern. The Team has reviewed the procedures used to assess the potential for liquefaction and the stability of the soils and found them to be consistent with the standard of practice. However, the analytical procedures involved simplifying assumptions and employed ground motion estimates that also included uncertainty. While the team does not doubt that liquefaction is possible during strong ground shaking, the engineering communities' ability to accurately predict the response of the seawall and viaduct to earthquake loading is crude.

The team also believes that mitigation of the liquefaction hazard should be carefully approached. Several methods are available and have been studied in the past. However, the best liquefaction mitigation alternative for retrofit may not be the best for new construction. Also, the possibility of allowing liquefaction to occur and designing new structures to accommodate the effects of liquefaction (e.g., lateral spreading and settlement) should be thoroughly explored.

Gray and Twelker proposed a combination of jet grouting around the existing pile groups and installation of stone columns between the viaduct and the seawall. The liquefaction mitigation techniques proposed by Gray and Twelker have merit. In fact, WSDOT also appears to favor jet grouting if the existing viaduct is retrofitted. If WSDOT and the City of Seattle proceed with an "interim" retrofit as suggested by Gray and Twelker, selection of the liquefaction mitigation technique should take into consideration the "permanent" solution. That is, consider using a mitigation technique that would be applicable to the long-term viaduct solution in addition to the interim retrofit.

Seawall Issues

The potential exists for upgrading the seawall and the Alaskan Way Viaduct simultaneously. There has been discussion about the ability to look at retrofitting the Viaduct as a separate issue from the seawall. However, both facilities are in a state of disrepair and both are embedded in soils that are highly liquefiable. While it may be possible to improve the ground of the viaduct without addressing the seawall, this approach may be misleading. The state of analysis of ground improvement and soil structure interaction in liquefiable soils that spread laterally is not highly developed. It is only within the last 10 years that the problem of evaluating how much a foundation will move in soils that spread laterally has been addressed. We can calculate numbers and make estimates, but we still will not truly know the behavior of the retrofit foundations until a large earthquake hits. The seawall is retaining highly liquefiable soil and we know that some, if not a lot, of the wall is supported on timber that is eroded away. Its capacity to retain the soil behind it during a large earthquake is marginal at best. Many feet of lateral movement should be expected. It would not be prudent to try to improve the soil and/or foundation under the viaduct without also improving the condition of the seawall and the soil adjacent to it.

Base Isolation

If the retrofit criteria used is the AASHTO guide specification criteria (which results in a maximum credible event peak ground acceleration of greater than 0.6g), then a retrofit as proposed by Gray and Twelker using base isolators and ground improvement would not reduce the load on the existing structure to below the 0.1g ground acceleration necessary to make it work. There are other concerns with the use of base isolators on such a series of structures on varied depths and types of soil.

The Gray and Twelker approach missed the fatal flaw that it is not possible to control or even predicts the direction and motion of the superstructure due to the numerous geometric anomalies and discontinuities as well as its overall length. Different parts will move in different directions thus significantly reducing the benefit of base isolation. It may be effective in keeping certain sections of the viaduct intact but it will not serve the purpose of making the structure safe overall. Even if one section fails, it means the end of the structures' usefulness.

We agree with WSDOT that base isolation as a retrofit alternative is not suitable for the viaduct because even the reduced forces below the design level earthquake would overstress the members, joints, and splices. In addition, the probable lateral displacement is likely to exceed the capacity of the existing expansion joints.

Other Considerations

Traffic Operations and Needs

The traffic issues for the Viaduct need to be integrated with the other regional transportation methods. The Viaduct has a certain carrying capacity now. The City of Seattle, King County, Sound Transit (the region), and WSDOT have plans to expand and improve transportation, and thereby, the carrying capacity to and through downtown Seattle. Implementation of the Sounder, the monorail, light rail, and improvements to the freeways may relieve some of the carrying capacity demand on the Viaduct.

The Gray and Twelker proposal stated that traffic congestion and operations would be a concern during a replacement of the viaduct. Their assumption must be that a retrofit of the viaduct can be done "under traffic". This assumption may be correct with the limited program that they suggested, However, to adequately retrofit the viaduct to meet even a relatively small earthquake event it is not likely that traffic can be maintained continuously. We were given the opportunity to review several concepts for retrofit and replacement options and agree with Gray and Twelker that maintenance of traffic during construction of any concept will be a major concern. Without a detailed plan for handling traffic during construction, comparing replacement with retrofit, it is not possible to draw a conclusion as the extent of disruption (number of lanes closed); duration of construction period and impact on local business access. Perhaps more important than traffic congestion impacts, will be the length of time to complete the project and the related costs to maintain a reasonable level of traffic and local access during retrofit or replacement.

Costs

On the issue of total project cost we can perhaps agree with Gray and Twelker. The public will be concerned with cost when one recognizes the vast need for transportation improvements in Central Puget Sound. Regarding $200 million for base isolation, this figure is too low and excludes many other structural problems that would also have to be included even if the base isolation were a viable solution. Gray and Twelker assume that all options will have the same capacity when completed. This may be true of the replacement options, but not the retrofit as they proposed. Their scheme would use base isolation and not change roadway widths or ramp configurations. Even with a retrofit plan as considered by WSDOT, there would be wider roadway widths providing added shy distance and breakdown area and many small changes could be made in ramp configurations, ramp locations and safety improvements. At whatever cost, the public needs to be assured that the expenditure and construction disruption will result in some "betterment" to the motoring public.

The design team apparently has not seriously begun to address costs, except on a broad basis and Gray and Twelker have oversimplified costs and their estimates are too low. Their costs for jet grouting the soils beneath the structure were about $700,000. The ground improvement for a small 300 by 30-foot area near the seawall is estimated to be about $400,000. The methods to improve the ground and install new foundations appear to be very preliminary, when you add in the extra costs of working in difficult conditions, around and over traffic, challenging construction techniques and other peculiarities of the project. We believe the real costs of a retrofit will be much higher than presently envisioned.

Risk

The key questions for retrofit relate to the level of risk in terms of the potential for failure that results in injury or death, the life of the structure, and the cost of the retrofit. These items are directly related. If a higher level of risk is acceptable, then perhaps a lower cost retrofit could be considered. Such a lower level of retrofit would probably result in shorter life span of the retrofitted structure. This is a policy question, one that might ultimately be decided by the funding agencies of the project, either the legislature or the voters.

Gray and Twelker questioned the risk evaluation approach and raised a concern that if the project is too costly a replacement or retrofit project will be delayed or may never be funded. The complication is how to define adequately the issues of risk so that the decision-makers and the public understand the implications. Would the public understand and accept a lower level of retrofit, to the level that provided life safety (and not functionality)? If a lower level of retrofit costs at least half of what it would be to meet the new criteria, then the public may ask that it meets more stringent (i.e. lower level of risk) criteria. The review team's opinion is that the 72-year interval would likely not be acceptable since that standard has been met or exceeded in the 1949, 1965, and 2001 events. The public perception would more likely be that a more stringent criteria should be set. The Panel believes it is harder to argue that the 475-year criteria should not be acceptable. The 475 year-year criteria has been the design standard event and provides a probability for a 10% chance in 50 years.

It might be worth looking at the level of retrofit required to meet the 475 year standard, and talking about the pluses and minuses of the retrofit as the public process goes on. How much would such a retrofit cost, and what functional and life-span improvements could be included. If the cost were more than 50% of the cost of a new project, and the new facility also improves safety or capacity, then the logical decision would be the new project. If not, then the public has a choice. A significant area that needs attention is the evaluation of the effects of retrofitting a portion of the structure (such as installing base isolation) on the behavior of the rest of the structure. A partial correction could expose some other elements of the structure to failure due to changes in loading on those elements.

To identify the preferred alternative there needs to be a comparison of life-cycle costs for each retrofit and replacement option. There is also a need to establish criteria for the cost comparison of retrofitting versus total replacement. These comparisons should include the life cycle costs for a predictable life span for each option. The retrofit costs should then be less than the total replacement costs by some percentage for a given retrofit life span (say, 50% of replacement costs for a retrofit life of 25 years). If the retrofit alternative life-cycle costs are more than the criteria. Total replacement option should become the favored plan

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Conclusions

As we have heard the various presentations, it is clear that the choice of what to do will and probably cannot be made on the basis of technical considerations only. If funding were not a consideration, immediate design and construction to create a safe and improved Alaskan Way Viaduct and Seawall should be pressed ahead. However, with the constraints on available money and the large demands for new construction and upgrades in our transportation system, a decision must be made as to where this project fits in the overall priorities of better or new facilities. If the economic consequences from the complete loss of the Viaduct and Seawall are significant in comparison to the economic gains forecast for other projects, then these facility improvements should probably rise to the top of the list.

The retrofit proposal of Gray and Twelker does not provide adequate reduction in the risk of the viaduct failure with a highly questionable method of base stabilization. The existing structure has numerous deficiencies including:

- Inadequate shear reinforcement in the girders and beams.
- Insufficient transverse reinforcement in the columns.
- Welds and reinforcement laps are not sufficient based on present codes.
- Considerable corrosion of steel reinforcement.
- Deck surface wear has exposed steel and has inadequate cover.
- Spalling concrete that is exposing steel.

These deficiencies require major rebuilding or replacement of key structural elements. The use of base isolation changes the forces on these elements and further reduces their capacity to resist earthquake loads. Further, the restricted movement capacity of the existing structure would not allow for the horizontal movement anticipated for a design level earthquake.

Liquefaction of the foundation soils is likely in an earthquake well below the design level event. A related seawall failure could cause the viaduct to fail due to the lateral movement of the foundation soils. The base isolation and ground improvement plan would probably not protect the viaduct from this type of lateral movement.

The ASCE panel finds that the retrofit option proposed by Gray and Twelker requires no further consideration, but agree that their concerns related to the cost implications of appropriate design criteria and standards do have merit. A major policy question to be addressed with this project is the level of expenditure related to the resultant public benefits. It is not a question of sufficient traffic demand to expand the viaduct facility, but rather of funding availability and how to allocate the limited resources in a manner the public will support and what are the consequences if the structure collapses

The other retrofit proposals that have been considered at this time are very expensive and are not likely to be cost effective in a life-cycle analysis. However, because of the funding, construction sequencing or traffic management, it may be necessary to retrofit sections of the viaduct for the general safety and welfare of the public.

Gray and Twelker questioned the mindset of the previous structural evaluation committee and felt that there were reasons such as “visual” or political that led to a recommendation to replace rather than retrofit the viaduct. To the contrary, the ASCE Panel felt that all evaluations to date had been very objective and the primary conclusions were technically based, not political. The Panel would note, however, that the complex decision making process for this project in many aspects <u>will</u> and should be political. The decisions to be made need to be based on solid technical analysis, however the final action involves major public policy direction that must come from our elected and community leadership, and represents the public interests in a responsible and reasonable manner.

Recommendations

WSDOT and the City of Seattle should proceed with evaluation of options to replace the Alaskan Way Viaduct. Retrofitting the 50 year old facility is not the technically preferred solution since it is doubtful that retrofitting is an effective approach to fully satisfying current design standards. However, retrofitting options should be carried forward for further analysis to allow for options that may be necessary because of funding constraints, implementation strategies, or other interests of WSDOT and the CIty. The retrofitting of some sections may be necessary as part of the overall staging of the project in order to maintain safety and traffic operations.. The plan to retrofit the viaduct as proposed by Gray and Twelker is not considered to be a viable option in any scenario and should not be pursued further.

The opportunity, or need, to integrate the seawall into the Viaduct project also needs further analysis and consideration. The upgrading of the Viaduct may be of greater priority than the rebuilding of the seawall, yet it would be prudent to improve the seawall while improving the Viaduct foundation. WSDOT should pursue common solutions to the foundations improvements needed, yet balance the seawall issue with the Viaduct decisions.

Continued review of the traffic impacts for each of the various options is important to a determination of reasonable solutions. This should include everything from a minimal four lane surface street to complete replacement of the facility with adequate geometric design for a six-lane highway. Consideration of other regional transportation solutions including mass transit should be incorporated into the traffic impact review

Continued analysis is recommended to fully understand the risks, opportunities and realities of options that will lead to the selection of a preferred plan. There needs to be a common basis from which the same criteria can be applied to all options that includes traffic, risk, cost, time, and foundation/structural variables. After the analyses are complete, there can be a review the results and a clearly stated recommendation can be provided to the City and State.

The ASCE Panel appreciates the opportunity to meet with WSDOT staff and WSDOT consultants regarding these issues, and looks forward to our further discussions as this critical project moves forward.

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